

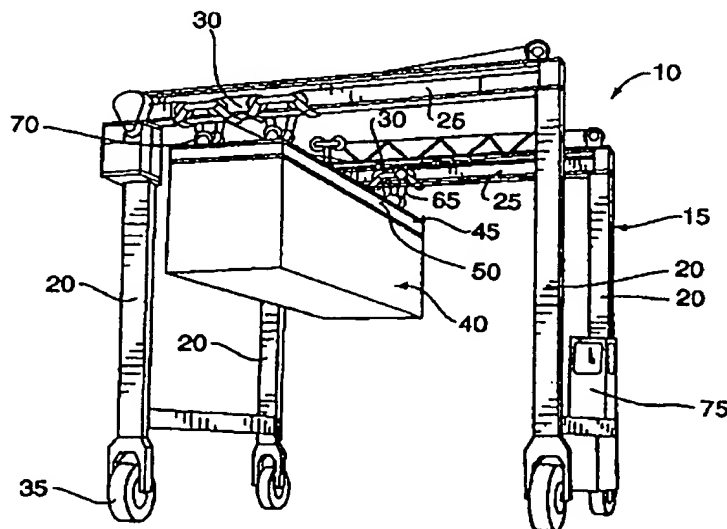
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/US99/08515 (22) International Filing Date: 16 April 1999 (16.04.99) (30) Priority Data: 09/073,381          6 May 1998 (06.05.98)          US (71) Applicant: MI-JACK PRODUCTS [US/US]; 3111 West 167th Street, Hazel Crest, IL 60429 (US). (72) Inventors: LANIGAN, Jack, Jr.; 1730 Giddington Court, New Lenox, IL 60451 (US). OLSON, Daniel, J.; 14152 Margarita, Orland Park, IL 60462 (US). (74) Agents: BELUSH, Thomas, A. et al.; Leydig, Voit & Mayer, Ltd., Suite 4900, Two Prudential Plaza, 180 North Statson, Chicago, IL 60601-6780 (US).	(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  Published <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	

(54) Title: GRAPPLER GUIDANCE SYSTEM FOR A GANTRY CRANE



## (57) Abstract

In a gantry crane (10) having a movable grapple (45) adapted for lifting standard containers (40), a system is provided to aid in positioning the grapple relative to the container. The grapple is equipped with at least two corner video devices (100) located near the corners of the grapple for viewing the corner locking holes (60) of a container below. An additional distal video device (105) can also be mounted to a side of the grapple opposite the cab to view the relative orientation of a side of the container relative to the side of the grapple. A plurality of alignment sensors (140) can also be mounted to respective sides of the grapple to detect the relative position of the corresponding sides of the container vertically below. A pair of height (120) sensors can also be mounted to the grapple to measure the height of the grapple above the upper surface of the container.

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**GRAPPLER GUIDANCE SYSTEM FOR A GANTRY CRANE**Background of the Invention

5 The present invention generally relates to a system for positioning a grapppler relative to a container to be lifted and more particular relates to a system for aiding in the guidance of the grapppler so that twistlock mechanisms of the grapppler may be precisely aligned with locking holes of a container.

10 Gantry cranes are conventionally used in railyards, shipping yards, and other places for loading and unloading large containers to and from railcars, trailers, pallets, etc. Such a crane typically has a sturdy steel frame with four vertical columns, upper horizontal beams fixed  
15 between the columns, and a lifting mechanism movably mounted to the beams. The lifting mechanism has twistlocks or spreader clamps to lockably engage the container in a standard manner.

The grapppler is movably suspended from the frame so  
20 that the grapppler can be positioned and lowered to engage a container. More specifically, the lifting mechanism generally includes a trolley transversibly mounted on the horizontal beams for side-to-side movement. Also, the grapppler is suspended from the trolley by cables or wire  
25 ropes or other means. On some cranes, the suspended grapppler may be moved forwardly or rearwardly along the trolley as well. Additionally, the hoisting means are operably movable to selectively lift and lower the grapppler.

30 The grapppler must be properly positioned and lowered to engage a container to be lifted. Specifically, the grapppler must be carefully landed on top of the container while aligning the four grapppler twistlocks with the four respective corner-located locking holes in the container.

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Properly landing the grapppler on a container with precise alignment in this manner has conventionally been difficult. A gantry crane conventionally has a cab which is mounted to the frame and which contains controls for driving the crane and positioning the grapppler.

5 Conventionally, the operator controls the grapppler by eyesight from a vantagepoint through the cab window. Accordingly, the operator has been typically required to maneuver and lower the grapppler to land on top of a

10 container with precise positioning.

Such manual "eyeball" positioning can be difficult, especially when the grapppler is moved to a distal position relative to the cab. The operator's ability to align the conventional grapppler in such a manner requires keen depth

15 perception, concentration and alertness. Extra personnel are sometimes required to stand near the container and provide hand signals to assist the operator. Additionally, changes in lighting and weather conditions may impede an operator's ability to accurately position

20 the grapppler.

Various positioning aids have been attempted in the art. For example, U.S. Patent No. 5,067,013 discloses a crane having two video cameras mounted at opposite corners of a grapppler. The cameras are directed downwardly toward

25 a container to be engaged. The video signals from the cameras are displayed on monitors in the cab to assist the crane operator in positioning the grapppler.

#### Summary of the Invention

30 The present invention provides an improved grapppler positioning system for a gantry crane. In particular, according to the invention, a grapppler is provided with a combination of various video devices and position sensors that provide information to aid in guiding the grapppler.

35 In an embodiment, the information is displayed on

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instruments and/or monitors in the cab so that an operator can appropriately manually guide the grappler. In another embodiment, the information may be analyzed by a computer which thereby automatically controls the grappler to an accurately positioned landing on a container.

According to the invention, at least two video devices are mounted to the grappler near respective twistlocks. These video devices are aimed downwardly to view the container below and to assist in guiding the grappler so that the twistlocks are properly received and engaged in correspondingly-positioned corner locking holes in a standard container. In combination with the video devices, the system also includes various distance-measuring sensors. Specifically, the system of the invention includes a pair of ultrasonic distance-measuring sensors which are mounted near longitudinally opposite ends of the grappler, each of the distance-measuring sensors measuring the distance between a point of the grappler and the upper surface of the container. A tilting of the grappler is indicated by a difference between the measured distances.

Additionally, an embodiment of the system further includes a distal video device mounted to a side of the grappler opposite the cab to provide a view of the grappler and container. In an embodiment, this distal video device has a wide angle or "fisheye" lens so that the operator has a broad view of the grappler and container from a perspective opposite his own.

Furthermore, an embodiment of the system includes four ultrasonic edge sensors mounted to respective sides of the grappler to detect the relative positions of respective quadrilateral edges of a container below. When each of the ultrasonic edge sensors detects that it is positioned vertically over the edge of the container, an associated light in the cab is actuated. When all four

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lights are actuated, the grappler is positioned so that it can be vertically lowered by the hoisting means to land on the container.

5 An advantage of the invention is that it provides an improved grappler positioning system for a gantry crane.

Another advantage of the invention is that it aids an operator in guiding a grappler to a container to be lifted.

10 A further advantage of the invention is that it provides a combination of helpful information which is displayed to an operator, including video pictures and other information indicating grappler distance and position.

15 Yet another advantage of the invention is that it provides guidance assistance by sensing the location of edges of a container relative to the grappler.

A still further advantage of the invention is that it increases safety in a loading environment. For example, the invention eliminates a need for extra personnel to stand near the loading activity and provide guidance signals to the operator, such as signals by hand, voice, radio, light, etc.

25 An additional advantage of the invention is that provides a system which increases container-handling efficiency of a gantry crane.

Additional features and advantages of the present invention are described in, and will be apparent from, the description of the invention herein, the claims, and the drawings.

30

#### Brief Description of the Drawings

FIG. 1 is a perspective view of a gantry crane constructed in accordance with teachings of the present invention.

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FIG. 2 is a schematic perspective view of the grapppler of the crane of FIG. 1.

FIG. 3 is a schematic perspective view of the grapppler of the crane of FIG. 1,

5 FIG. 4 is a schematic view of a grapppler positioning system according to teachings of the invention.

FIG. 5 is a front view of a monitor having a line on the screen providing a reference for the grapppler position relative to an edge of a container displayed on the  
10 monitor.

#### Detailed Description of the Drawings

Now turning to the Figures, wherein like numerals designate like components, FIG. 1 illustrates a mobile  
15 gantry crane 10 having a grapppler positioning system according to the invention. Generally, the crane 10 has a frame 15 including four vertical columns 20, upper horizontal beams 25 fixed between the columns 20, and a pair of trolleys 30 movably mounted to the respective  
20 beams 25 for transverse movement. The crane 10 includes a plurality of wheels 35 on which the crane 10 is rollably drivable.

For lockably engaging and lifting a container 40, the crane 10 has a lifting mechanism or grapppler 45 which is  
25 movably suspended from the trolleys 30. The grapppler 45 generally includes a body 50 having a container-grasping mechanism, such as four male twistlocks 55 (FIGS. 2, 3) mounted in a rectangular pattern corresponding to positions of locking holes 60 (FIG. 2) located at the top  
30 corners of a standard shipping container 40. The twistlocks 55 enable the grapppler 45 to lockably engage a container 40 for lifting, as described in greater detail below. Although the body 50 of the grapppler 45 is  
35 can of any suitable shape such that the twistlocks 55 are

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at the desired relative positions. The grappler 45 is generally aligned along a longitudinal axis which extends from front to back of the crane 10.

In other possible embodiments, the grappler 45 may have grappler arms (not shown) of a type which are generally known. When the grappler 45 is properly landed and/or aligned on a container, the grappler arms are pivoted to grab the container for lifting. Such arms may be provided in addition to, or in lieu of, the twistlocks 55.

In an embodiment illustrated in FIG. 1, the grappler 45 is suspended from the trolleys 30 by wire ropes 65. On the wire ropes 65, the grappler 45 is selectively lifted and lowered. The wire ropes 65 are coilably paid out and retracted from rotatable hoisting drums mounted to the respective trolleys 30. These wire ropes 65 pass around rotatable sheaves 70 fixed to the grappler 45. When the wire ropes 65 are moved, the suspended grappler 45 is caused to move vertically lower or higher. In another embodiment (not illustrated), the grappler 45 is fixed to the trolleys 30, and the beams 25 are movably mounted to engage tracks extending along the columns 20. The grappler 45 is vertically movable by operably driving the beams 25 along the columns 20.

The trolleys 30 are movable in a side-to-side manner, moving the suspended grappler 45 accordingly. The trolleys 30 include rollers to facilitate traversible travel of the trolleys 30 along the respective horizontal beams 25 of the frame 10. In an embodiment, the suspended grappler 45 may be movably mounted for forward or rearward movement along a longitudinal beam extending between the trolleys 30 as well.

Still referring to FIG. 1, the gantry crane 10 includes a cab 75 mounted to the frame 15 to accommodate an operator. The cab 75 contains controls for driving the



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crane 10 and positioning the grappler 45. The operator can view the grappler and container to be lifted through windows in the cab 75.

The grappler 45 must be properly positioned and lowered to engage a container 40 to be lifted. Specifically, the grappler 45 must be carefully landed on an upper surface 41 of the container 40 in corresponding alignment. For example, in the embodiment of FIGS. 2 and 3, the grappler must be lowered while the four twistlocks 55 are respectively aligned with the locking holes 60 located in the top of the container 40. When the grappler 45 is lowered in proper alignment onto the top of the container 40, the twistlocks 55 are matably received into the locking holes 60. The twistlocks 55 are then actuated to rotate within the holes 60, lockably securing the grappler 45 to the container 40 in a generally known manner for lifting and handling.

According to the invention, a grappler positioning system is provided to assist in positioning a grappler as it is lowered to engage a container. The system includes video devices in combination with position sensors that provide information to assist in properly guiding the grappler relative to the container.

In particular, referring to FIGS. 2 and 3, at least two corner video devices 100 are mounted to the grappler 45 at respective corners of the grappler body 50. More specifically, in the embodiment shown in FIGS 2 and 3, the video devices 100 are respectively mounted near at least two of the twistlocks 55. These video devices 100 are aimed generally downwardly to view the container 40 below, and particularly to view respective corner areas of the container 40 having the locking holes 60 disposed therein. The video devices 100 deliver images which are displayed in the cab 75.

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The image provided by each video device 100 enables the operator to adjust the side-to-side or front-to-back position of the grapppler 45 relative to the container 40 as the grapppler 45 is lowered to properly align the  
5 respective twistlocks 55 with the corresponding locking holes 60. By providing at least two of the corner video devices 100, the operator is able to align two corners of the grapppler 45 relative to the container 40, thereby also aligning corners of the grapppler not equipped with video  
10 devices 100. Embodiments are possible, however, wherein more than two corners of the grapppler 45 are equipped with video devices 100.

In an embodiment of the invention, as illustrated in FIGS. 2-3, a pointer 102 is mounted to the grapppler body  
15 50 near a respective one of the video devices 100. The pointer 102 is an elongated member which extends downwardly. At least a tip portion of the pointer 102 is viewable by one of said video devices 100 to provide a point of reference of the location of an edge of the  
20 grapppler 45. As the grapppler 45 is maneuvered relative to a container 40, the position of the pointer 102 helps an operator gauge the position of the grapppler 45. In the illustrated embodiment, the pointer 102 is disposed along the side of the container when the grapppler is lowered to  
25 land on top of the container. The pointer 102 may be pivotably mounted and/or constructed of a resilient material so that the pointer 102 is not damaged if brought into contact against the container 40.

In an embodiment of the invention, as illustrated in  
30 FIG. 3, a distal video device 105 is mounted to a side of the grapppler 45 opposite the cab 75 to provide a downward view of the container 40. In an embodiment, this distal video device 105 has a wide angle or "fisheye" lens. The distal video device 105 provides a view which assists the  
35 operator to align the side of the grapppler 45 with the

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side of the container 40.

Each of the video devices 100, 105 delivers a video signal via a cable 106 (FIG. 3) which is displayed in the cab 75 on one or more monitors 110, as illustrated in FIG.

5 4. Signals from the video devices 100, 105 are delivered to a processor 111, which delivers a signal to the monitor 110, which may be a CRT, LCD screen, or some other known type of display. In an embodiment, a single monitor 110 is operable display the view from a selected one of the  
10 video devices 100, 105, and a switch 115 is provided to permit selection between the various video devices 100, 105. In another embodiment, multiple video monitors 110 are provided, displaying views from the respective video devices 100, 105. In a still further embodiment, a  
15 monitor 110 can have a split display to show images from of a plurality of the video devices 100, 105.

In the embodiment which includes the distal video device 105, the monitor 110 may be adapted to indicate a visual reference of the position of the grapppler relative  
20 to the container 40. More specifically, illustrated in FIG. 5 is the monitor 110 displaying the view from the distal video device 105 (FIG. 3) directed downwardly from the grapppler 45. The monitor 110 has a screen 112 across which has a line 113 is provided. The line 113 is to  
25 represents an orientation of the side of the grapppler 45. As illustrated in FIG. 5, an edge 240 of the container 40 is displayed on the screen 112 as viewed from the distal video device 105. The line 113 is positioned on the screen 112 such that when the line 113 overlies or  
30 otherwise corresponds to the image of the edge 240 of the container 40, the grapppler 45 is properly oriented with the edge 240 of the container 40. The line 113 can be generated electronically and displayed as an overlay on the screen 112, or the line 113 can be physically applied  
35 to the screen 112, such as by tape. With the monitor 110

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of the embodiment shown in FIG. 5, an operator can detect the position the grapppler 45 relative to the displayed edge 240 container 40 and accordingly adjust the position of the grapppler to align the line 113 with the edge 240.

5 The foregoing procedure can also be used to align the grapppler 45 with a trailer for typical bottom picking applications with the grapppler arms (not shown).

Also illustrated in FIGS. 2 and 3, for measuring a distance  $h$  between the grapppler 45 and an upper surface 42  
10 of the container 40, an embodiment of the invention further includes at least two height sensors 120 are mounted to the grapppler 45. The height sensors 120 are spaced from each other so that a tilting of the grapppler 45 can be detected by a difference in the heights measured  
15 by the respective height sensors 120. Particularly, in an embodiment, a pair of height sensors 120 is mounted to an underside of the grapppler 45 such that the sensors 120 are spaced from each other in a longitudinal direction.

Preferably, the height sensors 120 operate by with  
20 ultrasonic waves. As illustrated in FIG. 2, each of the height sensors 120 emits ultrasonic waves 125 which are reflected from the upper surface 42 of the container 40. By detecting the time for the reflected waves to return to the sensor, a generally downward distance  $h$  is measured  
25 between a respective one of the height sensors 120 and the upper surface 41 of the container 40. A distance measurement corresponding to each of the sensors 120 is displayed on a readout 130 in the cab 75, as shown in FIG. 4.

30 In an embodiment, the processor 111 detects when the height sensors 120 are measuring substantially different respective heights, assuming a tilted orientation of the grapppler 45 relative to the container 40. The processor 111 then actuates a warning indicator 135 to alert the  
35 operator to the tilted condition or to display the degree

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of tilt.

In a further embodiment, the system includes a plurality of alignment sensors 140 mounted to respective sides of the grapppler 45, as shown in FIGS. 2 and 3. Each  
5 of the alignment sensors is operable to detect the relative positions of a corresponding edge of the container 40 below. Preferably, the system includes four alignment sensors 140 mounted at the four respective sides of the grapppler 45. The sensors 140 are connected to  
10 actuate respective indicators in the cab 75 for example, lights 145 as shown in FIG. 4, when the sides of the grapppler 45 are properly aligned vertically above the corresponding sides of the container 40. When the lights 145 indicate that the grapppler 45 is aligned vertically  
15 above the container 40, as indicated by the dashed lines 146 in FIG. 3, the operator can simply lower the grapppler 45 to a properly aligned landing atop the container 40.

The video devices 100 and/or 105 are preferably video cameras which produce a real-time image. Alternatively,  
20 the video devices 100 and/or 105 may be some other sort of image generating device such as infrared cameras or appropriate image-mapping transducers.

In an embodiment, the grapppler positioning system of the invention may be automated so that the grapppler 45 is  
25 automatically guided and lowered in proper alignment for engaging the container 40. In such an embodiment, the processor 111 is programmed determine the position of the grapppler 45 relative to the container 40 from the signals delivered from the video devices 100, 105 and/or sensors  
30 120, 140. Furthermore, the processor 111 then controllably adjusts the position of trolleys 30 and the motion of the hoist means to carefully lower the grapppler 45 relative to a container 40 with proper alignment of the twistlocks 55.

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Although the invention is described herein in connection with certain preferred embodiments, it is recognized that various changes and modifications to the invention will be apparent to those skilled in the art.

- 5 Such changes and modifications may be made without departing from the spirit and scope of the invention. Accordingly, the appended claims are intended to cover all such changes and modifications.

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## WHAT IS CLAIMED IS:

1. A gantry crane having frame and a vertically movable grappler supported by the frame, the grappler  
5 being operable to engage and lift a container, the grappler having a plurality of twistlocks positioned to engage locking holes in a container, the gantry crane also having a grappler positioning system including:
  - at least two video devices mounted to the grappler at  
10 respective corners of the grappler near the twistlocks;  - at least one monitor operable to display a video image from at least one of the cameras;  - a plurality of alignment sensors, each alignment sensor being mounted near a respective side of the  
15 grappler between two of the twistlocks for sensing a relative position of a respective side of a container vertically below; and  
an indicator actuatable by a respective one of the alignment sensors to indicate when the respective side of  
20 the grappler is aligned vertically over the side of the container.
2. A crane according to claim 1, wherein the alignment sensors are ultrasonic sensors.  
25
3. A crane according to claim 1, further comprising a switch operable to selectively display a view from one of said video devices on said video monitor.
- 30 4. A crane according to claim 1, wherein at least one of said video devices is a video camera.
5. A crane according to claim 1, wherein at least one of said video devices is an infrared camera.

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6. A crane according to claim 1, further comprising a plurality of height sensors mounted to the grapppler sensing respective distances of the grapppler from an upper  
5 surface of the container and a height display located in the cab displaying a height detected by the height sensors.

7. A crane according to claim 6, wherein the height  
10 sensors are ultrasonic sensors.

8. A crane according to claim 1, further comprising a distal video device mounted to a side of the grapppler opposite the cab and directed generally downwardly to  
15 provide a view of the grapppler and container.

9. A crane according to claim 1, wherein the distal video device has a wide angle lens.

20 10. A crane according to claim 1 wherein the distal video device is mounted to the grapppler generally at a midpoint in a longitudinal direction between the corners of the grapppler.

25 11. A crane according to claim 1, further comprising a pointer mounted to extend generally downwardly from the grapppler so that a portion of the pointer is viewable by one of said video devices.

30 12. A grapppler guidance system for a gantry crane of a type having a frame supporting a vertically movable grapppler which is operable to grasp and lift container, the grapppler having a plurality of twistlocks positioned to engage locking holes at upper corners of a standard  
35 container, the gantry crane further having a grapppler



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positioning system including:

at least two corner video devices mounted to the grapppler at near respective twistlocks;

5 a distal video device mounted to a side of the grapppler opposite the cab and directed generally downwardly to provide a view of an edge of the container;

at least one monitor operable to display a video image from at least one of the video devices;

10 a plurality of alignment sensors, each alignment sensor being mounted near a respective side of the grapppler between two of the twistlocks for sensing a position of a respective side of a container vertically below relative to the side of the grapppler; and

15 an indicator actuatable by a respective one of the alignment sensors to indicate when the respective side of the grapppler is aligned vertically over the side of the container.

20 a plurality of height sensors mounted to the grapppler, each of the height sensors sensing a respective distance between the grapppler and an upper surface of the container;

a readout located in the cab displaying a height detected by the height sensors.

25 13. A grapppler guidance system according to claim 12, wherein the alignment sensors are ultrasonic sensors.

14. A grapppler guidance system according to claim 12, further comprising a switch operable to selectively  
30 display a view from one of said video devices on said video monitor.

15. A grapppler guidance system according to claim 12, wherein at least one of said video devices is a video  
35 camera.

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16. A grapppler guidance system according to claim 12, wherein at least one of said video devices is an infrared camera.

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17. A grapppler guidance system according to claim 12, wherein the height sensors are ultrasonic sensors.

18. A grapppler guidance system according to claim 12, wherein the distal video device has a wide angle lens.

10

19. A grapppler guidance system according to claim 12, wherein the distal video device is mounted to the grapppler generally at a midpoint in a longitudinal direction between the corners of the grapppler.

15

20. A grapppler guidance system according to claim 12, wherein the height sensors are located generally near opposite longitudinal ends of the grapppler.

20

21. A grapppler guidance system according to claim 12, further comprising a pointer mounted to extend from the grapppler so that a portion of the pointer is viewable by one of said video devices.

25

22. A grapppler guidance system for a gantry crane of a type having a frame supporting a vertically movable grapppler which is operable to grasp and lift container, the grapppler having a plurality of twistlocks positioned to engage locking holes at upper corners of a standard container, the gantry crane further having a grapppler positioning system including:

30

at least two video cameras mounted to the grapppler at near respective twistlocks;

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at least one monitor operable to display a video image from at least one of the video devices;

5 a plurality of height sensors mounted to the grapppler, each height sensor being operable to sense a respective distance between the grapppler and an upper surface of the container, the height sensors being spaced from each other; and

a readout located in the cab displaying respective heights detected by the height sensors.

10

23. A grapppler guidance system according to claim 22, wherein the height sensors are spaced from each other in a longitudinal direction.

15

24. A grapppler guidance system according to claim 22, wherein the height sensors are located generally near opposite longitudinal ends of the grapppler.

20

25. A grapppler guidance system according to claim 22, wherein the display alerts the operator to a difference in the respective distances measured by the height sensors.

25

26. A method for guiding a grapppler to lift a container, the method comprising:

providing a vertically movable grapppler which is operable to grasp and lift container;

30

providing a distal video device mounted to the grapppler and directed generally downwardly to view an edge of the container;

providing at least one monitor operable to display a video image from at least one of the video devices, the monitor having a screen with a line extending across the screen representing an orientation of the grapppler; and

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adjusting the position of the grapppler so that said line corresponds to an edge of the container as displayed on the screen.

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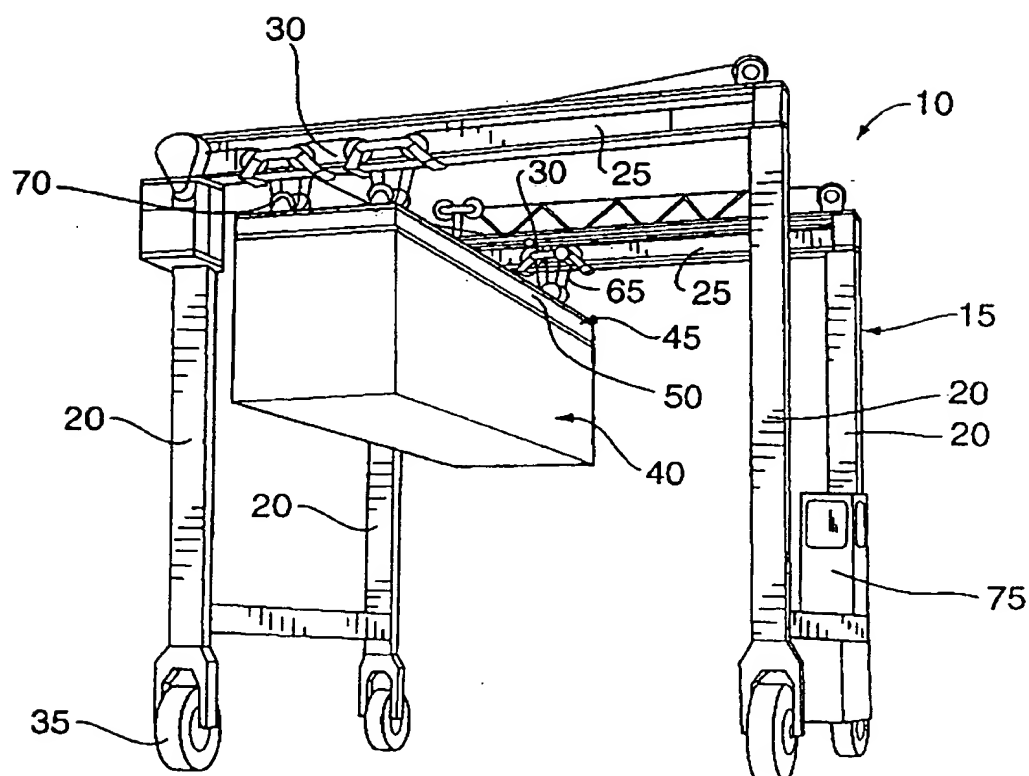


FIG. 1

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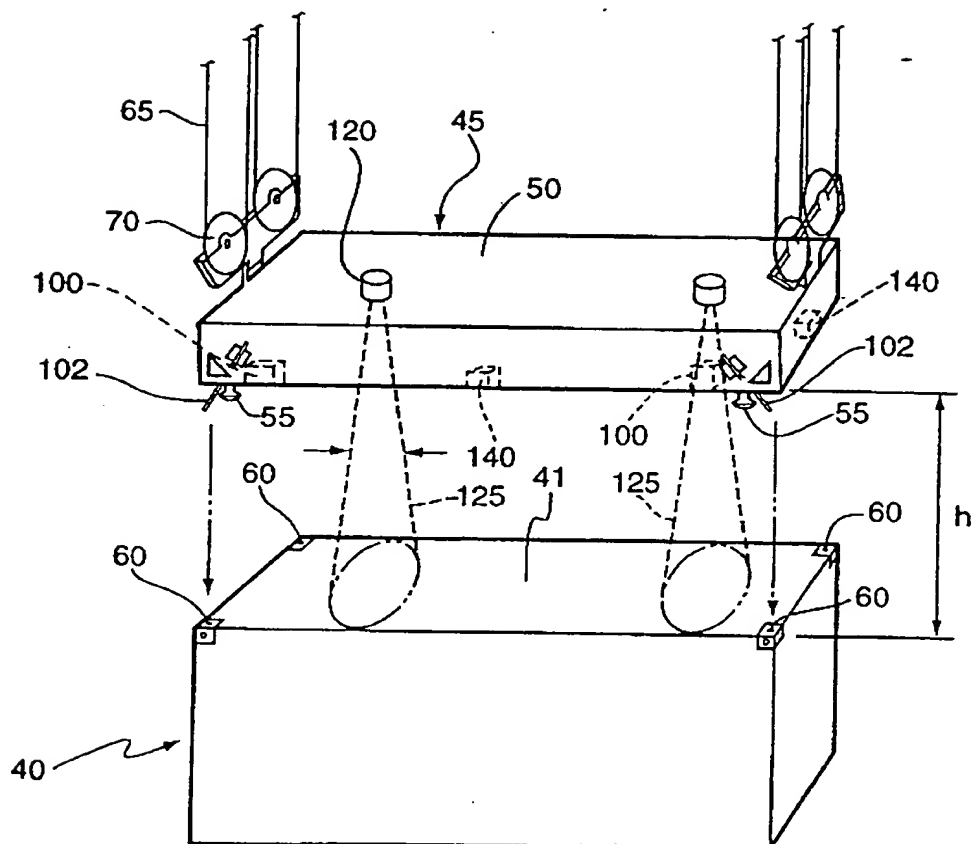


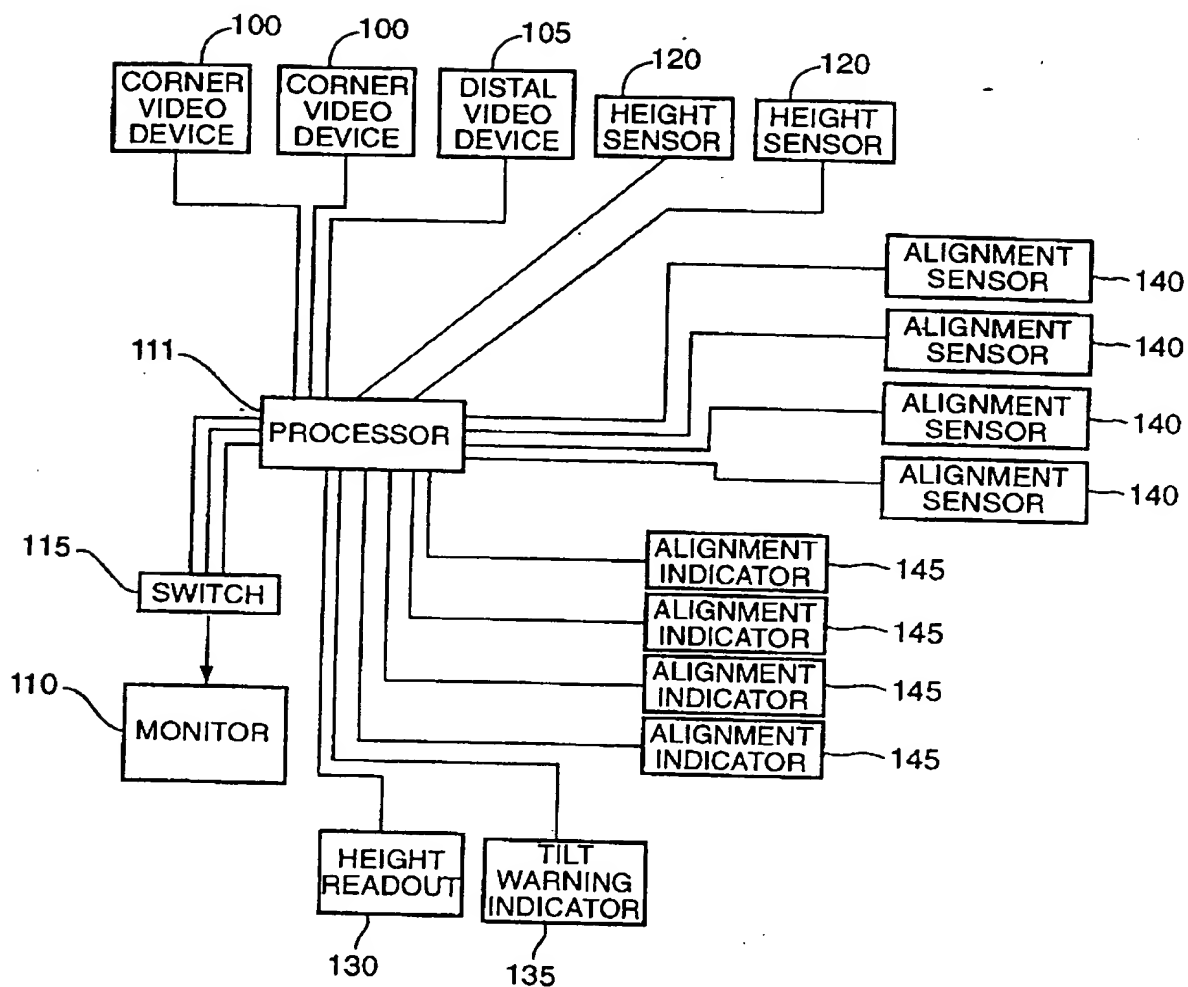
FIG. 2

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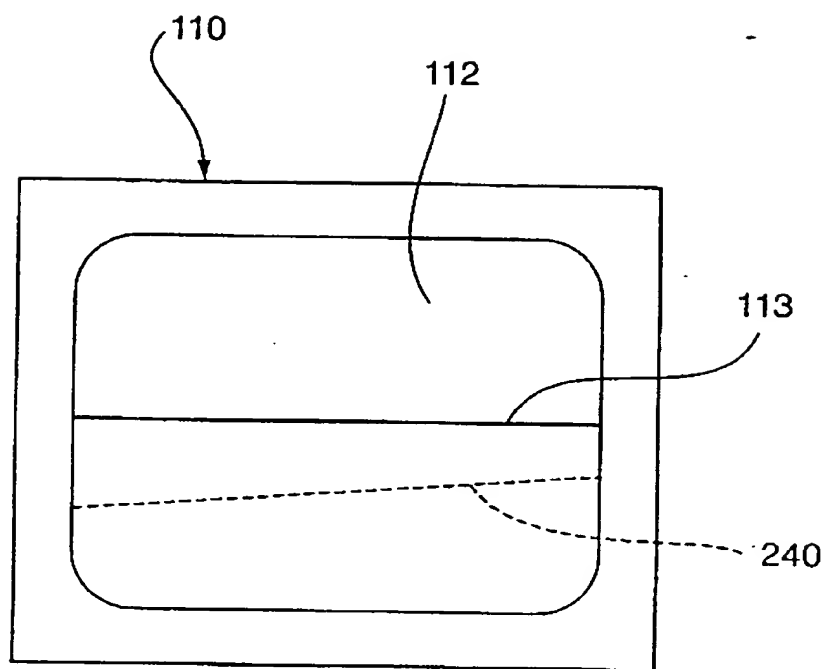
**FIG. 4**



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**FIG. 5**

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/08515

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : H04N 7/18

US CL : 348/61

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/61,86,94,95,135,162,163,164

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: crane, video, infrared, ultrasonic, wide angle, fisheye

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X - Y	US 5,067,013 A (LINDHOLM et al) 19 November 1991, col. 4, lines 18-29, Fig 4, col. 2, lines 18-58.	3-4, 11, 14-15, 21 ----- 1-2, 5-10, 12-13, 16-20, 22-26
Y	US 4,139,107 A (NINOMIYA et al) 13 February 1979, col. 4, lines 48-65, Fig 3.	1-2, 12-13, 20, 22-24
Y	US 5,154,561 A (LEE) 13 October 1992, col. 25, line 28-39, col. 27, line 35-40, col. 18, line 37-col. 19, line 35.	1-2, 6-9, 12-13, 17-18, 22, 25-26
Y	US 5,491,549 A (WICHNER et al) 13 February 1996, col. 4, lines 7-30, col. 5, lines 50-59.	10, 19
Y	US 4,419,079 A (GEORGES et al) 06 December 1983, col. 4, lines 7-30.	26

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*B* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

06 AUGUST 1999

Date of mailing of the international search report

10 SEP 1999

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/08515

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,754,672 A (MONZEN et al) 19 May 1998, col. 3, lines 1-56.	5,16